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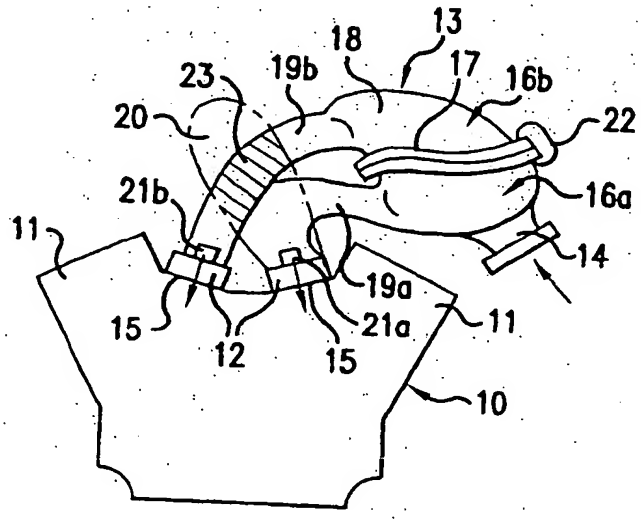
(54) Title: AIR INTAKE TUBE FOR AN INTERNAL COMBUSTION ENGINE



(57) Abstract: An air intake, especially for internal combustion engines with a V-shaped cylinder arrangement, which is composed of two units (16a, 16b). From the two units (16a, 16b) extend the intake ducts (19a, 19b), each associated with one cylinder bank (11) of the internal combustion engine. By dividing the air intake device into two units (16a, 16b), the unit (16a) can be mounted first on the internal combustion engine, a free space (20) for the mounting tool being necessary. Then the unit (16b) is placed and bolted on, the air intake ducts (19b) being able to run through the free space (20) in the hatched area (23), since the unit (16a) is already installed. The advantage of this air intake tube configuration is a substantially greater geometric freedom of design.

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AIR INTAKE TUBE FOR AN INTERNAL COMBUSTION ENGINE

BACKGROUND OF THE INVENTION

The invention relates to an air intake tube for an internal combustion engine which especially has two cylinder banks in a V arrangement.

Air intake tubes of the kind described above are known. For example, EP 352 820 A1 (= US 4,981,115) shows in Figure 2 an intake tube for an internal combustion engine with a V-shaped arrangement of the cylinders. The intake tube has two manifold chambers 14F and 14R, from which intake ducts 15F and 15R branch out. The latter are bolted with flanges 9a and 9b to the cylinder head of the internal combustion engine. Figure 2 of this document shows a top view of the intake tube. It is clear that the intake ducts must have a geometry that permits access of a tool to screws 19. This is a requirement for automated mounting of the intake tube on the cylinder head.

Thus the geometrical possibilities for configuring the intake tube are subject to certain limiting conditions which restrict the freedom of configuration. Moreover, the intake tube must be made with high accuracy since it must be supported at two different areas of the internal combustion engine by its cylinder head flanges.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide an intake tube which offers very great freedom for the configuration of the intake ducts.

It is also an object of the invention to provide an intake tube which can be manufactured at moderate cost.

These and other objects are achieved by the present invention by providing an air intake tube for an internal combustion engine having at least two banks of cylinders, especially in a V array, wherein the air intake tube includes a first group of intake ducts for one cylinder bank and a second group of intake ducts for another cylinder bank; the intake tube comprises two units joined releasably together, the first unit containing the first group of intake ducts and the second unit containing the second group of intake ducts, and the volumes formed by the two units communicate with one another.

In accordance with further aspects of the invention, the objects are also achieved by providing an air intake tube for an internal combustion engine, wherein the air intake tube comprises two units joined releasably together, the volumes formed by the two units communicating with one another, while the releasable connection comprises a plug-in junction which is sealed by a gasket relative to the surrounding environment, and the gasket has a failure pressure limit which is lower than the bursting pressure of the intake tube.

The air intake tube of the invention is especially suited for an internal combustion engine with the cylinder banks in a V arrangement. To correspond to the cylinder banks, the intake ducts are divided into a first and second group. It is also possible within the scope of the invention to configure the intake tube for an internal combustion engine with cylinders in a W arrangement. In this case the intake ducts must be divided into three groups to correspond to the arrangement of the cylinders.

The intake tube of the invention is characterized in that the tube is comprised of two units joined releasably together. The units contain the respective groups of intake ducts. The units then are connected together such that the volumes formed by the two units communicate with one another. Air can be readily introduced into the intake tube through a central inlet. The air flows from this inlet through manifold chambers and thence through the intake ducts to duct outlets at the cylinders. Of course, it is also possible within the scope of the invention to provide a plurality of inlets for the combustion air.

By dividing the intake tube into two units, the freedom of configuration of the intake tube geometry can be advantageously increased without substantially increasing the number of units. Especially when the units are to be made by casting, the complexity of the two components is reduced to a special degree, so that they can more simply be made in molds.

According to one specific embodiment of the invention, the intake tube has two or more manifold chambers. In the case of a V arrangement of the cylinders, an especially practical solution is achieved by providing two manifold chambers. The aforementioned two groups of intake passages or ducts extend from these chambers to the cylinder banks. The two units are releasably attached to each other such that the two manifold chambers communicate with one another. In such a case, interactions between the two manifold chambers can be utilized in order to improve the intake performance of the tube. Each of the manifold chambers furthermore has smaller dimensions than a single chamber intended for all of the intake ducts would have, so that a greater rigidity can be achieved in the intake tube.

In accordance with one specifically preferred embodiment of the intake tube of the invention, the units are joined together by a plug-in connection or a flanged joint. These joints are releasable and are easy to handle when mounting the intake tube. Use of a plug-in connection additionally permits compensation of dimensional inaccuracies between the two units arising from manufacturing tolerances. This equalization of inaccuracies can be achieved, for example, by an axial shifting of the plug-in connection. In such a case the plug-in connection is configured such that a seal relative to the surrounding environment is possible in several axial positions. The plug-in connection can furthermore be designed such that a limited angular inaccuracy between the two units can be compensated. The advantage of such a configuration lies in the low tolerance requirements for manufacture of the individual units, which lowers the production costs.

In accordance with an alternative embodiment, the units joined releasably together have a gasket at the junction point, which has a pressure limit for failure. This pressure limit is selected to be lower than the bursting pressure of the intake tube. Consequently, the gasket additionally serves the purpose of a safety valve in case the internal combustion engine reaches an unacceptable operating condition. In this case failure of the intake tube resulting in an explosive accident is avoided. Using the gasket to relieve excess pressure represents a substantially lower hazard potential. Also, after the failure the gasket can be replaced with a low-cost repair gasket, while failure of the complete intake tube would necessitate more expensive reconstructive measures.

In one preferred embodiment, the manifold chambers of the two units communicate with one another through two releasable connections. In this case the interactions between the two manifold chambers can be utilized in a special manner. In one of the two connections a resonance valve can be disposed which can be opened or closed depending on the load on the internal combustion engine. Using such a valve the duct geometry can be varied to adjust the conditions under which the intake tube loads or charges the internal combustion engine with intake air. Arranging a resonance valve in one of the two connections also permits this comparatively complex component to be installed in the intake duct in a comparatively simple manner. Easy replacement in case of component wear or failure is likewise facilitated.

It is especially advantageous to provide a plug-in joint and a flanged joint for connecting the two units to form the intake tube. The flanged connection permits the two units to be reliably fixed to each other, for example by bolting. The plug-in joint can be designed to offset dimensional inaccuracies arising from manufacturing tolerances etc., so that tolerances between the two units can be

compensated. The use of two connections can be combined with the use of a resonance valve in order to achieve the above-described advantages for the charging of the internal combustion engine.

Another advantage of the intake tube units according to the invention is that the second unit can be arranged such that it lies in a workspace required for tools used to mount the first unit to the internal combustion engine. This requires that it be possible to attach the second unit to the already installed first part, i.e., the fasteners for mounting the second unit on the first unit must be accessible after the first unit is mounted on the internal combustion engine. In this manner the geometric freedom of configuration is greatly improved, especially for the course of the intake ducts of the second part. This has manufacturing advantages, since more possibilities exist, for example, for paying attention to questions such as where to locate the parting plane of the molds used to form the parts. Also the duct unit can be designed to produce better intake air flow conditions due to the free selectability of the duct geometry. In particular, the free selectability of the duct geometry makes it easier to satisfy the requirement that the intake ducts for all the cylinders be the same length.

It is advantageous to manufacture the air intake tube from synthetic resin material or plastic. The intake tube may be produced, e.g., by injection molding. The result is light weight intake tubes manufactured at low cost. A preferred embodiment is obtained by making the units with multiple-shell molds. By using two units, each of the units can be constructed from, for example, two shells without great expense, thus forming the entire intake tube from a total of four molded shells. Thus the manufacturing costs can be kept within reasonable limits. The connection of the individual shells can be accomplished by welding or adhesive bonding. It is especially desirable to join the shells by vibration welding.

These and other features of preferred embodiments of the invention, in addition to being set forth in the claims, are also disclosed in the specification and/or the drawings, and the individual features each may be implemented in embodiments of the invention either individually or in the form of subcombinations of two or more features and can be applied to other fields of use and may constitute advantageous, separately protectable constructions for which protection is also claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in further detail hereinafter with reference to illustrative preferred embodiments shown in the accompanying drawings in which:

Figure 1 is a schematic representation of an internal combustion engine with cylinders in a V configuration and an installed air intake tube;

Figure 2 is a perspective view of a first unit of a two unit air intake tube;

Figure 3 is a perspective view of the assembly of a second unit on the first unit according to Figure 2; and

Figure 4 is a schematic representation of a section taken through a plug-in junction between units of multi-unit intake tube.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 shows an internal combustion engine 10 with two cylinder banks 11 in a V array. Above the cylinder head flange 12 an air intake tube 13 is attached to the cylinder head of the internal combustion engine. Combustion air from an intake tract (not shown) enters the intake tube 13 through an inlet 14 and leaves through outlets 15.

The intake tube 13 is comprised of a first unit 16a and a second unit 16b. Together with a flange 17, the two units 16a and 16b form a manifold chamber 18 with a first set of intake ducts 19a extending from the lower unit 16a of the manifold chamber 18 and second set of intake ducts 19b extending from the upper unit 16b of the manifold chamber. These ducts 19a and 19b terminate in cylinder head flanges 12.

The intake tube 13 is mounted on the internal combustion engine 10 in the following order. First the lower intake unit 16a is bolted through the cylinder head flange to the cylinder head of the internal combustion engine. In order to accomplish this, the work area or assembly space 20 indicated by broken lines is necessary to enable the required assembly tools to access the mounting bolts. An automated assembly tool is inserted therein, which functions to attach the first unit 16a to the cylinder head with screws 21a which extend through the flange 12 at the ends of ducts 19a. After the first unit 16a is mounted and the assembly tool has been retracted out of work space 20, intake unit 16b can then be mounted on intake unit 16a, for example by means of attachment clamps 22. The hatched portion 23 of work space 20 needed for attaching the intake unit 16a is now blocked by the second set of intake ducts 19b. This is not a problem, however, because work space 20 is no longer needed since intake unit 16a is already fastened to the cylinder head of the internal combustion engine. Lastly, the intake unit 16b can be fastened with screws 21b to the internal combustion engine.

The intake unit 16a shown in a perspective view in Figure 2 is intended for an air intake tube which is suitable for a six-cylinder internal combustion engine. The intake ducts 19a extend from a manifold chamber 18a to the cylinder head

flange 12. Intake unit 16a is fastened with screws 21a to the internal combustion engine, which is not shown, the arrows 24 pointing to the needed space for an appropriate assembly tool.

The intake unit 16a has two junction points 25, both of which communicate with the manifold chamber 18a. In the broken-away part of intake unit 16a, a resonance valve 26 can be seen, which prevents gas flow from manifold chamber 18a to one of the junction points. The intake unit 16b, not shown, is connected to the two junction points 25 such that its manifold chamber 18b communicates through the junction points 25 with the manifold chamber 18a of intake unit 16a.

The attachment of intake unit 16b to intake unit 16a can be seen in Figure 3. Broad arrows 27a and 27b indicate the movements executed by unit 16b as it is attached to unit 16a which has already been mounted on the internal combustion engine which is not shown in this figure. First, as indicated by arrow 27a, a plug-in connection 28 is made at one of the junction points 25 with an O-ring 29 sealing the connection. This plug-in connection brings the air intake tube 30 on unit 16b into communication with manifold chamber 18a of unit 16a. Intake tube 30 carries a flange 31, e.g., for connecting a throttle valve and an intake device containing the air filter. A second manifold chamber 18b branches off from intake tube 30, and the second set of intake ducts 19b extend from manifold chamber 18b to the other cylinder bank of the internal combustion engine. Intake ducts 19b likewise terminate through a common cylinder head mounting flange 12.

After the plug-in connection 28 has been made, the intake unit 16b can be rotated as indicated by arrow 27b to bring cylinder head mounting flange 12 into abutment with the cylinder head of the internal combustion engine. The cylinder head mounting flange 12 associated with the intake ducts 19b can be affixed to the cylinder head with bolts 21b as shown in Fig. 1. At the same time, the rotation of intake unit 16b also brings connecting flanges 32 at the other junction point 25 into abutting relation so that they can be bolted together as indicated by arrows 24.

The flanged junction 32 and the plug-in junction 28 are formed at the connection points 25 shown in Figure 2 on the unit 16a. In this manner the manifold chambers 18a and 18b communicate with one another. The resonance valve 26 shown in Figure 2 is contained in an additional volume 33 of the intake tube, which expands the two manifold chambers 16a and 16b.

The plug-in junction 28 is represented schematically in a sectional view in Figure 4. An opening or receptacle 34 is formed on unit 16a and a plug-in nipple 35 carrying the O-ring 29 is formed on unit 16b. The O-ring lies in the opening 34, and the plug-in nipple 35 does not come in contact with unit 16a. Through use of the O-ring 29 it is possible to compensate for dimensional variations which arise

due to manufacturing and assembly tolerances. Moreover, the O-ring 29 can serve as a kind of pressure relief valve in case the pressure in the air intake tube becomes unacceptably large. This can happen, for example, in the case of a backfire, i.e., the propagation of the exploding mixture from the cylinder through an unclosed intake valve into the intake tube.

The foregoing description and examples have been set forth merely to illustrate the invention and are not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed broadly to include all variations falling within the scope of the appended claims and equivalents thereof.

WHAT IS CLAIMED IS:

1. An air intake tube for an internal combustion engine with at least two banks of cylinders, said air intake tube including a first group of intake ducts for one the two cylinder banks and a second group of intake ducts for the other of the two cylinder banks, wherein said intake tube comprises two units joined releasably together, one of said two units comprising the first group of intake ducts and the other of said two units comprising the second group of intake ducts, and wherein said two units define respective first and second interior volumes which communicate with one another.

2. An air intake tube according to claim 1, wherein the two units are joined together by a plug-in junction, and the respective interior volumes defined by said two units communicate with one another through the plug-in junction.

3. An air intake tube according to claim 2, said plug-in junction compensates for dimensional variations in said units due to manufacturing tolerances.

4. An air intake tube according to claim 1, wherein the two units are joined together by a flanged junction, the respective interior volumes defined by said two units communicate with one another through the flanged junction.

5. An air intake tube according to claim 1, wherein the respective interior volumes defined by the two units communicate with one another through two releasable junctions, and a resonance valve is arranged in one of the two junctions.

6. An air intake tube according to claim 5, wherein said two releasable junctions comprise a plug-in junction and a flanged junction.

7. An air intake tube according to claim 1, wherein one of said units when joined to the other extends at least partially into a work space for an assembly tool for attaching the other unit to the internal combustion engine, and wherein the one unit can be attached to the other unit after the other unit is attached to the internal combustion engine.

8. An air intake tube for an internal combustion engine with at least two banks of cylinders; said intake tube including a first group of intake ducts for one

the two cylinder banks and a second group of intake ducts for the other of the two cylinder banks; the first group of intake ducts extending from a first manifold chamber and the second group of intake ducts extending from a second manifold chamber; wherein said air intake tube comprises first and second units joined releasably together; said first unit comprising said first group of intake ducts and said first manifold chamber, and said second unit comprising said second group of intake ducts and said second manifold chamber, and said first and second manifold chambers communicating with one another.

9. An air intake tube according to claim 8, wherein said first and second units are joined together by a plug-in junction, and respective interior volumes defined by said first and second units communicate with one another through the plug-in junction.

10. An air intake tube according to claim 8, wherein said first and second units are joined together by a flanged junction, and said first and second units define respective interior volumes which communicate with one another through the flanged junction.

11. An air intake tube according to claim 8, wherein the respective manifold chambers of said first and second units communicate with one another through two releasable junctions, and a resonance valve is disposed in one of the two junctions.

12. An air intake tube according to claim 8, wherein said first and second units are connected together by a plug-in junction and by a flanged junction with the respective manifold chambers of said first and second units communicating with one another through said plug-in junction and through said flanged junction, and wherein said plug-in junction compensates for dimensional variations due to manufacturing tolerances.

13. An air intake tube according to claim 8, wherein said second unit when joined to said first unit extends at least partially into a work space for an assembly tool for attaching said first unit to the internal combustion engine, and wherein said second unit can be attached to said first unit after said first unit is attached to the internal combustion engine.

14. An air intake tube for an internal combustion engine, said air intake tube comprising two units joined together by a releasable junction, said two units

defining respective interior volumes which communicate with one another, said releasable junction comprising a plug-in junction which is sealed relative to a surrounding environment by a gasket, and said gasket having a failure pressure limit which is lower than a bursting pressure of the intake tube.

15. An air intake tube according to claim 14, wherein said air intake tube is for an internal combustion engine having at least two cylinder banks, and said air intake tube includes a first group of intake ducts for one of the cylinder banks and a second group of intake ducts for another of the cylinder banks, a first of said two units comprising said first group of intake ducts and a second of said two units comprising said second group of intake ducts, and wherein said releasable junction is provided between the two units which comprise the air intake tube.

16. An air intake tube for an internal combustion engine with at least two cylinder banks; said intake tube including a first group of intake ducts for one of the two cylinder banks and a second group of intake ducts for the other of the two cylinder banks, wherein said air intake tube comprises first and second units joined together by a releasable junction, said first unit comprising the first group of intake ducts, and the second unit comprising the second group of intake ducts; said first and second units defining respective interior volumes which communicate with one another; said releasable junction comprising a plug-in junction which is sealed relative to a surrounding environment by a gasket, and said gasket having a failure pressure limit which is lower than a bursting pressure of the air intake tube.

17. An air intake tube according to any one of claim 1-16, wherein the air intake tube is made from synthetic resin material by an injection molding method.

18. An air intake tube according to claim 17, wherein at least one of the units comprises an assembly of a plurality of molded shells.

19. An air intake tube according to claim 18, wherein said plurality of molded shells are welded together to form said assembly.

20. An air intake tube according to any one of claims 1-16, wherein said intake tube is for an internal combustion engine having two banks of cylinders arranged in a V array.

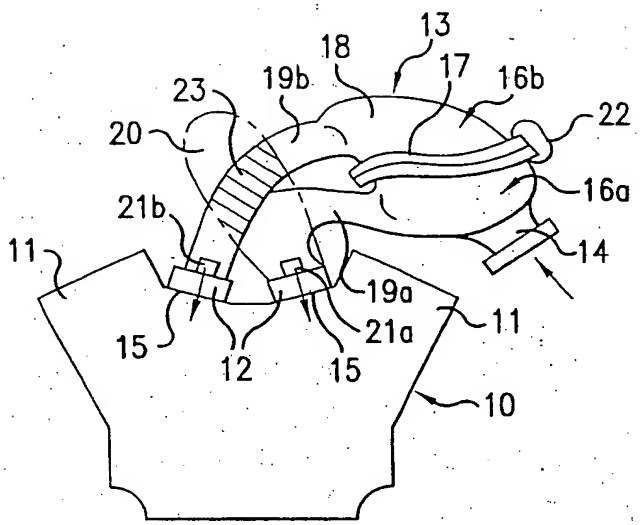

FIG.1

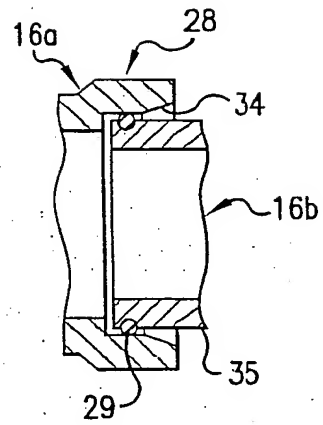

FIG.4

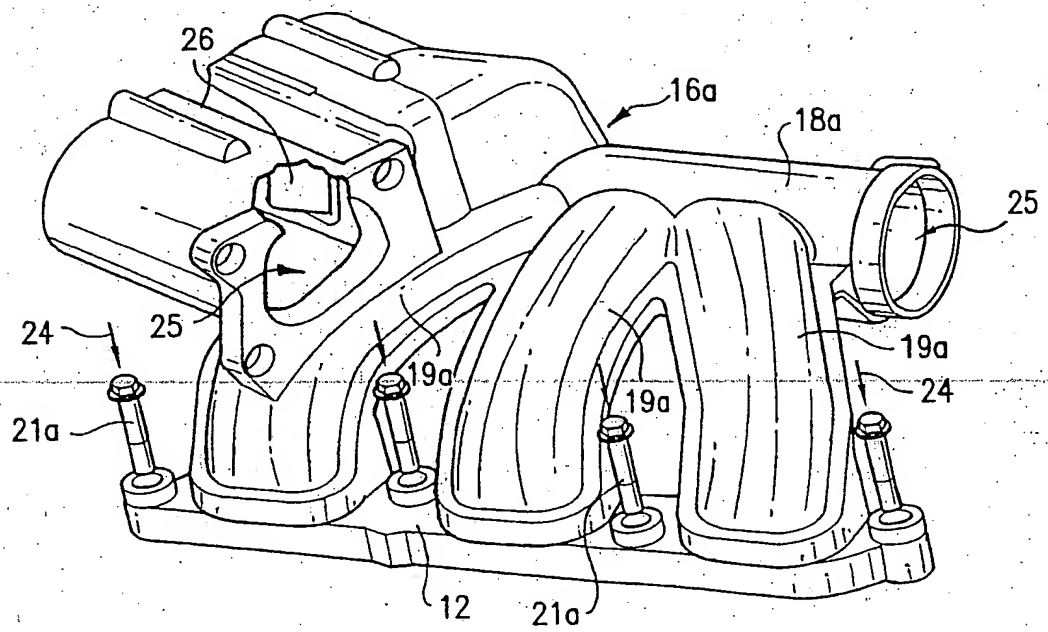

FIG.2

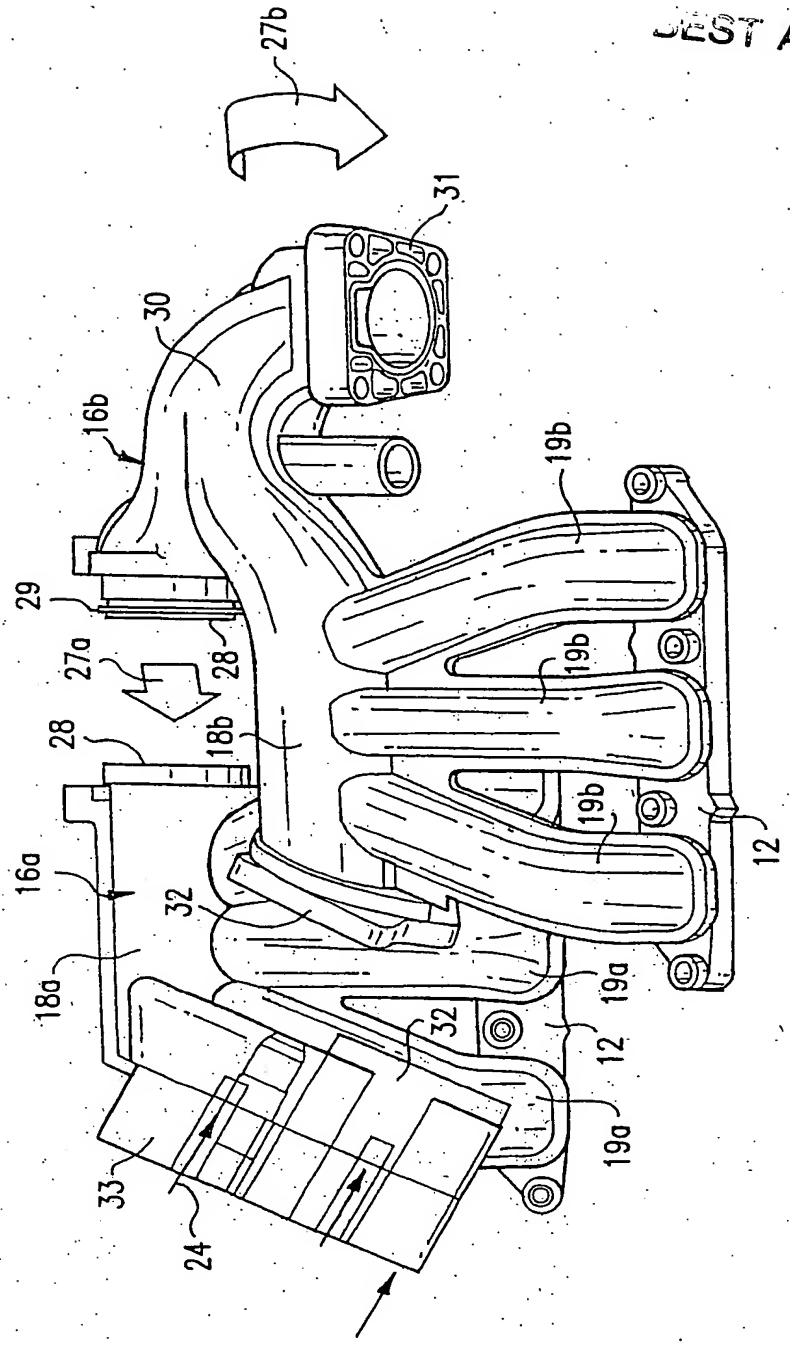

FIG.3

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) F02M 37/10
US CL 123/184.24, 184.31
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
US 123/184.24, 184.31, 184.25, 184.26, 184.35, 184.36, 184.42, 184.43, 184.44, 184.47, 184.48, 184.49

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,630,386 A (UCHIDA) 20 May 1997, see entire document.	1-20
A	US 5,839,404 A (NUMATA et al) 24 November 1998, see entire document.	1-20

☐ Further documents are listed in the continuation of Box C ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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